LIGHT-WEIGHED DIAPHRAGM PUMP

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a diaphragm pump for use in sucking and ejecting air or a liquid.

2. Related Art

In determining the amount of a selected gas contained in the atmosphere, use is made of a detector tube, which is connected to a fixed quantity pump. A fixed quantity of air is sampled from the surrounding atmosphere by operating the handle of the pump. The shaft of the pump is moved to draw the fixed quantity of air for measurement.

A certain gas contained in the surrounding atmosphere has been reduced in concentratio these days, and accordingly the sampled air required for the quantitative analysis needs to be increased in quantities. Consequently the number of handle operations in sampling air as much as required for the purpose increases to the extent that the pumping is a considerable burden to the operator.

JP 5-141362(A) shows an electric-powered pump whose con rod has a diaphragm connected to its end. The con rod is of a metal, and a flexible diaphragm is fixed to the con rod with screws. The con rod-and-diaphragm combination consists of a number of metal parts. This requires a tedious work in assembling, and the pump is relatively heavy. Also, the drive motor is heavily loaded, and consequently a relatively large quantity of electric power is consumed. Still, disadvantageously the drive motor cannot start quickly.

SUMMARY OF THE INVENTION

In view of the above one object of the present invention is to provide a diaphragm pump whose con rod-and-diaphragm combination consists of a minimum number of parts to be assembled, and is light in weight, and easy and quick to start, consuming a least quantity of electric power.

To attain this object a diaphragm pump comprises at least a drive motor, an eccentric member connected to a shaft of the drive motor, a con rod operatively

connected to the eccentric member, and a diaphragm connected to the con rod to be operated via the con rod when the drive motor rotates, is improved according to the present invention in that the con rod is made of a synthetic resin material, and that the con rod has an annular groove made next to its enlarged end, the diaphragm being of rubber, and being integrally connected to the enlarged end of the con rod by fitting into the annular groove, wrapping the enlarged end of the con rod.

The synthetic resin material may be a polyamide resin.

The con rod may have an adhesive or bond interface between the enlarged end and the diaphragm.

The diaphragm pump may further comprise umbrella-like valves on its suction and ejection sides.

With this arrangement it can make the con rod-and-diaphragm combination light in weight, and easy and quick to start, consuming a least quantity of electric power, and manufacturing work efficiency.

The use of polyamide resin as the synthetic resin makes it easy to form the con rod made of a synthetic resin material and the diaphragm integrally.

Other objects and advantages of the present invention will be understood from the following description of a diaphragm pump according to one preferred embodiment of the present invention, which is shown in accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

Fig.1 is a cross section of a diaphragm pump according to the present invention;

Fig.2 is an exploded cross-section of the diaphragm seat and hose fitting;

Fig.3 is a front view of the con rod-and-diaphragm combination, showing the diaphragm as being partly fractured; and

Fig.4 illustrates how the diaphragm pump operates.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

Referring to Fig.1, a diaphragm pump 1 according to the present invention comprises a housing which is consisted of a first housing part 2a with a hook 3 on its edge and a second housing part 2b with a counter recess on its edge, both housing parts being integrally connected by making the hook 3 to be caught by the counter recess.

In the housing a drive motor 4 is connected to a printed circuit board 6 via a lead wire 5. The printed circuit board 6 is connected to a power source (not shown). In case the diaphragm pump 1 is portable, the power source is preferably a battery. It, however, may be designed so that an AC power supply may be used.

The drive motor 4 has an eccentric member 8 connected to its shaft 7, and a con rod 9 made of a synthetic resin material is connected by the joint 9a to a shaft 8a of the eccentric member 8.

The synthetic resin material to form the con rod 9 may be polyamide resin such as modified polyamide. Preferably such a resin material remains resistive to thermal deformation over 230 degrees Celsius.

A rubber diaphragm 10 is connected to the enlarged end 9b of the con rod 9. The rubber diaphragm 10 and the resin con rod 9 are united into a single piece.

A pump body 11 is laid on a hose fitting 12 with "O"-rings 13 pressed therebetween. Rubber "O"-rings may be used. The pump body-and-hose fitting 11 and 12 is fastened to the bottom of the housing.

The first housing part 2a has a diaphragm seat 14 provided on in its bottom. Specifically the diaphragm seat 14 is a block having a composite hole made therein. The composite hole is composed of relatively larger and smaller holes both communicating with each other. The smaller hole 14a is smaller in diameter than the diaphragm 10, whereas the larger hole is as large as the diaphragm 10.

The diaphragm 10 is sandwiched on the circumference between the annular seat 14 and the retainer 15, so that the pump body 11 is fastened to the bottom of the housing, and the hose fitting 12 is fixedly applied to the pump body 11 in an airtight fashion.

Referring to Fig.2, the pump body 11 has two umbrella-like valves 16 on its suction and ejection sides. Specifically, the pump body has two composite holes 17a and 17b made therein, a number of suction ports 18 made around the hole 17a of the suction side, and a number of ejection ports 19 made around the holes 17b of the ejection side. The shank 16a of each umbrella-like valve 16 is slidably fitted in the hole 17a or 17b so that the flat head 16b of each valve 16 may open and close the surrounding suction ports 18 or the ejection ports 19 when the valve 16 moves up and down.

As seen from Fig.2, each umbrella-like valve 16 has an annular projection 16c formed on its shank 16a thereby making the valve 16 to be caught by the annular

area 17c or 17d, which is defined between the larger hole section and the smaller hole section of the composite hole 17a or 17b. Thus, each umbrella-like valve 16 cannot come off from the hole 17a or 17c.

The pump body 11 has annular grooves 20 made around its areas confronting to the suction and ejection passages 21 and 22 of the hose fitting 12, and the "O" rings 13 are press-fitted in these annular grooves 20, thereby limiting air-suction and ejection to the suction and ejection passages 21 and 22 of the hose fitting 12.

Referring to Fig.3, the con rod 9 has an annular groove 9c made next to its enlarged end 9d. The enlarged end 9d and grooved part of the shank of the con rod 9 is put in a metal mold, and rubber molten at about 220 degrees C is injected into the metal mold to form a rubber diaphragm 10 around the enlarged end 9d and grooved part of the shank.

Thus, the rubber diaphragm 10 is integrally connected to the enlarged end 9d of the con rod 9, partly invading into the groove 9c of the shank 9b, wrapping the enlarged end of the con rod 9. The enlarged end 9d of the con rod 9 is larger in diameter than the circular opening 10a of the diaphragm 10, thus preventing the diaphragm 10 from departing the con rod 9.

Preferably the con rod-to-diaphragm diameter ratio is from 1 to 2 to 1 to 3. The appropriate selection of the con rod-to-diaphragm diameter ratio effectively reduces the loading of the movable portion of the diaphragm 10, and accordingly the degree of fatigue of the diaphragm 10 can be reduced.

The con rod may have its enlarged end 9d coated with an adhesive agent beforehand and preferably dried. When the molten rubber spreads over the adhesive coating in the metal mold, the adhesive coating turns into an adhesive interface 23 between the enlarged end 9d and the rubber diaphragm 10, thus connecting the enlarged end 9d to the diaphragm 10 even still more fixedly than otherwise.

The diaphragm 10 has a rising ridge 10b on its circumference, which is collapsed when the diaphragm 10 is pinched between the diaphragm seat 14 and the retainer 15, thus providing the diaphragm pump with improved air-tightness.

The con rod-and-diaphragm mold is smaller and lighter than the conventional con rod-and-diaphragm comprising two separate parts integrally connected with screws, and use of such a light single piece contributes the significant reduction of the

loading of the drive motor and the power consumption, and permitting the drive motor to start quickly. Also advantageously the con rod-and-diaphragm mold requires no assembling work, accordingly permitting reduction of the number of assembling steps.

Referring to Fig.4, the manner in which the pump body 11 works is described. As shown in the drawing, the pump body 11 and the hose fitting 12 are integrally connected together, and the con rod-and-diaphragm combination has its enlarged end-and-diaphragm placed in the space delimited by the annular seat 14 and the retainer 15.

The con rod 9 is connected by the joint portion 9a to the eccentric member 8. The joint portion 9a may have a bearing 24 inside to rotatably support the eccentric member 8 therein.

When the drive motor 4 starts, the shaft 7 and hence the eccentric member 8 rotates. Consequently the con rod 9 moves up and down. Then, the diaphragm 10 moves up and down at its center, and accordingly the pressure is raised or lowered in the closed space 25, which is delimited between the diaphragm 10 and the retainer 15.

The diaphragm 10 is fixedly held by the circumference between the annular seat 14 and the retainer 15, and therefore, the circumference of the diaphragm 10 cannot come off even though the center area of the diaphragm 10 moves up and down.

When the diaphragm 10 rises to lower the pressure in the closed space 25, the umbrella-like valve 16 on the suction side rises, thus drawing air or liquid from the suction port 18 into the closed space 25 through the suction passage 18. The closed space 25 is kept airtight; the diaphragm 10 is pinched by the circumference between the retainer 15 and the annular seat 14, completely preventing the air from leaking.

When the diaphragm 10 moves down to raise the pressure in the closed space, the umbrella-like valve 16 on the ejection side is lowered to open the ejection port 19, thus permitting ejection of the air from the closed space 25.

In case a qualitative analysis is carried out in respect of a selected gas content in the air, a gas detector tube is connected to the ejection passage 22 via the hose (not shown).

The lightweight diaphragm pump facilitates a required qualitative analysis in

the field, and the power consumption is so low as to permit use of a battery as power source. The diaphragm pump is described as being small and light, but even if it is large, the weight is significantly less than the conventional diaphragm pump whose con rod-and-diaphragm is composed of separate parts joined together by screws.

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